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THE TOXICITY OF DIESEL OIL TO DOUGLAS-FIR CONES

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ABSTRACT: Applications of diesel oil exceeding 5 gallons per acre killed young cones of Douglas-fir. Possible reductions in seed quality were noted in cones which survived the oil application.

Diesel oil is a commonly used solvent for insecticides applied in controlling forest insects. It has many valuable properties, including excellent spreading and sticking qualities, which would make it useful in spraying conifers to protect the cones from insect pests. One of its disadvantages, however, is that it is often toxic to plants, especially new growth. Consequently, before recommending diesel oil for sprays to be used against insects that attack Douglas-fir cones, we tested its toxicity to the cones themselves.

The toxicity of oil to plant life was well known as early as 1763[1]. From about 1920 into the 1940's, much research was done on the effects of oil on plants and on the development of oils with special characteristics for use on plants. In general, researchers found that unsaturated hydrocarbons were the most harmful and that the tender new growth of plants was more susceptible to damage than older or dormant parts. Conifers were found to be generally more resistant than broad-leaved trees. Petroleum oils have been reported to kill leaves, buds, twigs, and whole trees. They have been found to interfere with photosynthesis and respiration and to reduce fruit set and delay or interfere with ripening of various fruits.[2]

1/ Shepard, H. H. The chemistry and action of insecticides. 504 pp., illus. New York: McGraw-Hill Book Co., Inc. 1951.

2/ Young, P. A. Physiological and physical effects of spray oils on deciduous trees. Jour. Econ. Ent. 34(6):838-844, illus. 1941.

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Diesel oil is not one of the specially refined oils developed for use on plants. It is, in fact, a fairly good herbicide and is sometimes used for this purpose. But many insecticidal compounds are directly soluble in diesel oil. The oil is cheap, readily obtainable, and stable in storage. For these reasons insecticides are often formulated with this liquid as the carrier, in spite of its phytotoxic properties. Sprays made with diesel oil have been applied in coniferous forests to control defoliating insects at rates up to 20 gallons per acre, without apparent ill effects.[3/]

To see if diesel oil could be used with equal safety in controlling cone and seed insects, experiments were conducted during the spring of 1960 and 1961 to determine the effect of different dosages on young Douglas-fir cones.

In 1960, four cone-bearing branches on each of three trees were sprayed with diesel oil at rates intended to approximate dosages of 1, 5, 10, and 20 gallons per acre. Two branches on each tree served as checks. The oil was applied on April 13 as a fine spray from the single nozzle of a 2-gallon pressure tank sprayer. The amount of oil applied was estimated by comparison of oil-sensitive cards attached to the branches with similar cards previously sprayed at known rates in a precision spray chamber.[4/] The nozzle was adjusted to produce droplets of approximately the same size as those produced in the spray chamber. The branches were inspected at weekly intervals for signs of cone mortality.

All cones receiving dosages of oil equivalent to 5 gallons or more per acre subsequently died. Of the cones receiving the equivalent of 1 gallon of diesel oil per acre 31.6 percent died. Of the checks, 42.5 percent died (table 1).

All the cones which were sprayed at the equivalent of 10 and 20 gallons per acre died within 2 or 3 weeks after treatment. Most of the mortality from the lower dosages also occurred within 2 or 3 weeks, but two cones which received the 5-gallon dosage and two which received 1 gallon died between 6 and 8 weeks after treatment. This delayed cone mortality, and some foliage burning on the branches receiving the 20-gallon per acre treatment, seemed to be associated with high air temperatures in the first week of June.

In the spring of 1961, a similar experiment was conducted on other Douglas-fir trees in the same area. Diesel oil was applied as described previously at rates approximating 5 and 10 gallons per acre. Cone-bearing

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3/ Stevens, R. E., and Struble, G. R. Entomological phases of the 1959 lodgepole needle miner control project in Yosemite National Park. U.S. Forest Serv. Pacific SW. Forest & Range Expt. Sta. 27 pp., illus. 1960.

4/ Lyon, R. L., and Bushing, R. W. The construction and performance of a portable precision spray chamber. Canad. Ent. 93(9):785-794, illus. 1961.

branches of each of three trees received each treatment. Two unsprayed branches on each of the same trees served as checks. In this test, all cones which survived the oil treatment were harvested at maturity, and the seeds were counted and examined in an attempt to determine if the seed yield or quality was affected.

Table 1.--The toxic effect of diesel oil applied to young Douglas-fir cones

Treatment and year	Replicates							
	1		2		3		Total	
	Sprayed	Survived	Sprayed	Survived	Sprayed	Survived	Sprayed	Survived
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Unsprayed								
1960	12	8	9	100	12	75	33	58
1961	14	100	8	100	8	38	30	83
1 gal./a.								
1960	6	0	8	100	5	100	19	68
1961	--	--	--	--	--	--	--	--
5 gal./a.								
1960	6	0	9	0	4	0	19	0
1961	9	100	15	87	6	33	30	80
10 gal./a.								
1960	12	0	5	0	4	0	21	0
1961	8	62	15	27	6	100	29	52
20 gal./a.								
1960	5	0	10	0	7	0	22	0
1961	--	--	--	--	--	--	--	--

The effect on the cones was less drastic than in the 1960 tests (table 1). Forty-eight percent of the cones sprayed at the rate of 10 gallons per acre died; about 20 percent died in both the 5-gallon-per-acre treatment and in the check.

The cones were heavily damaged by larvae of Dioryctria abietella (D. and S.) in late summer. As a result, the seed yield from the cones could not be used to measure the possible effect of the oil on the quantity of seed produced. The seeds which survived the insect attack were examined, and we found that the treated cones produced a lower percentage of filled seeds than the untreated ones. Thirty-six percent of the seeds from cones of the 5-gallon per acre treatment were filled, as were 40 percent of the seeds from cones of the 10-gallon per acre treatment, and 45 percent of the seeds from unsprayed cones. But, only one of the cone samples yielded enough seeds for a statistically adequate sample.

The results of the 1960 and 1961 tests differed somewhat, but they clearly indicate that diesel oil will kill Douglas-fir cones if applied at rates in the range of 5 to 10 gallons per acre. The differences between the two tests may have been due to differences in composition between the two lots of diesel oil used. But variations in the cones and weather conditions would also affect the results. In any event, diesel oil should not be used in insecticide formulations sprayed on Douglas-fir cones if the rate of application will approach 5 gallons per acre.

If spraying at rates exceeding 5 gallons per acre is contemplated to control cone and seed insects, it would be advisable to use formulations that can be prepared with water. Emulsifiable and wettable powder preparations of most of the common insecticides are readily available. Possibly some of the special oils developed for use on plants could be used for this purpose. But before these oils can be recommended, further research on their effects on the cones and seed yield will be necessary.

NOTICE: A uniform system of naming report series has been adopted for Forest Service Experiment Stations. Beginning January 1, 1963, research documents published by the Forest Service will be in one of these three series

1. A numbered series, U.S. Forest Service Research Papers.
2. A numbered series, U.S. Forest Service Research Notes.
3. A numbered series, U.S. Forest Service Resource Reports.

The publishing unit will be identified by letters before the number, and the numbers will be consecutive in the order of publication dates. For example, this Station's first Note in 1963 is designated U.S. Forest Service Research Note PSW-1. Certain miscellaneous material, such as annual reports and experimental forest guides, will continue to be issued as unnumbered, non-serial publications.

The Research Note series formerly published by this Station closed with the release of Research Note No. 211, 1962.